Research Note

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
OGDEN UTAH

USDA Forest Service
Research Note INT-115

1970

INFILTRATION IN CONTOUR TRENCHES IN THE SIERRA NEVADA

Norbert V. D[illegible][1]

ABSTRACT

Infiltration rates for water ponded in the bottoms of contour trenches constructed in the Sierra Nevada were determined by means of double-ring infiltrometers. The average rate in coarse-textured soils derived from granite was 19.5 inches per hour, more than six times the 3-inch-per-hour rate measured in fine-textured soils derived from andesite. These widely differing rates should be considered when designing a trench network. The probable influence of contrasting infiltration rates on water yields is discussed.

Contour trenches have been used for more than three decades in the West to control erosion and to permit revegetation of damaged mountain watersheds.[2] They work; when properly constructed, they halt erosion. Nevertheless, their design and function are largely based on empirical tests and quantitative information about their hydrologic effects is lacking.

Since trenches pond surface runoff, the rate at which this ponded water infiltrates is an important facet of their hydrology and should be considered in the design of a trench network. Further, this infiltration rate probably will influence the timing and amount of water yields from the trenched watershed.

METHODS

An exploratory study of infiltration in contour trenches was conducted in 1963 on the east side of the Sierra Nevada near Reno, Nevada. About 110 lineal miles of contour trenches had been constructed on the burned area of the Dog Creek watershed after the 1960 Donner Ridge fire. These trenches were restricted to denuded slopes having gradients of approximately 30 to 60 percent. The trenches studied were in a small catchment on the west side of that watershed, where soils derived from both andesitic and granitic parent materials were available. The andesite had weathered into fine-textured soils that possessed relatively low infiltration capacities. Granitic soils,

---

[1]Plant Ecologist, stationed in Logan, Utah, at Forestry Sciences Laboratory, maintained in cooperation with Utah State University.

[2]Edward L. Noble. Sediment reduction through watershed rehabilitation. 29 p. Paper presented at the Fed. Interagency Sedimentation Conf., Jackson, Miss., Jan. 1963.

on the other hand, were coarse textured and the ponded water infiltrated readily. The sites used for studying infiltration in contour trenches were chosen from these two soil types.

Double-ring infiltrometers were used on six sites during the late summer of 1963, 1 year after trench construction. Each site consisted of two or three successive trenches, each divided into four test locations approximately 20 feet apart. Consequently, 8 or 12 tests were conducted per site. Sixty-four individual infiltrometer tests were made--24 on granitic soils, 40 on andesitic soils. Immediately before testing, a soil sample was taken from the bottom of each trench and its moisture content measured gravimetrically.

The inner (intake) infiltrometer rings were 9 inches in diameter; the outside (buffer) rings were about as large (21 inches in diameter) as would fit into the bottom of a typical trench. Before each test, an inner ring was driven 2 inches into the soil at the lowest point in the trench bottom and an outer ring was inserted deep enough to hold water. The water level in the inner ring was measured by means of a hook gage immediately after both rings were filled and at frequent intervals thereafter. Water levels in both rings were kept approximately equal; the head in each was allowed to vary between 8 and 2 inches. Whenever infiltration reduced the head in the inner ring to 2 inches, both rings were rapidly refilled to the 8-inch level.

Infiltration rates were based on the time required for 30 inches of water to infiltrate trench bottoms or for a 24-hour continuous test--whichever occurred first. However, tests were made throughout the daylight hours only; so if enough water infiltrated during the night to empty infiltrometers, infiltration periods could not be established. When this occurred, rates were determined from data recorded the previous day. If infiltrometers did not drain dry overnight, rates were based on 24-hour periods.

RESULTS

Most infiltration rates were much greater during the first few minutes of a test than after 10 to 30 minutes had passed. High initial rates probably were due in part to dry soils. Before testing, decomposed granite soils held only 4.4 percent and andesitic soils about 13.1 percent moisture by weight, percentages at or near their respective wilting points. A relatively constant infiltration rate usually was attained within the first 15 minutes. However, this rate varied somewhat with fluctuations in the head of water in the infiltrometer.

Infiltration rates and the time periods over which they were determined are summarized according to site in table 1. Site 4 (three trenches constructed in the fine-textured soil derived from andesite) had the slowest infiltration rate, only 0.61 inch per hour. Site 5 (three trenches constructed in the coarse-textured soil derived from granite) had the fastest rate, almost 23 inches per hour. Each of these rates is the average of 12 tests. As a matter of interest, of the 64 individual tests run, the slowest one (0.01 inch per hour) also was recorded on Site 4 and the most rapid (51.5 inches per hour) on Site 5. Note especially that the average infiltration rate in the bottom of trenches constructed in coarse granitic soils was approximately six times that in the bottoms of trenches constructed in the fine-textured andesitic soils; this is a highly significant difference.

The amounts of accumulated infiltration at selected time intervals (5, 10, 20, 40, and 80 minutes after testing began) were computed and tabulated. These data then were averaged by site and graphically portrayed in figure 1. Data from tests that extended beyond 80 minutes indicate a relatively constant rate of infiltration. In fact, in most instances, the rate is shown to be constant after the first 10 minutes.

Table 1.--Infiltration rate in contour trenches on six sites

Site no.	Soil	Average infiltration period	Infiltration rate: Average infiltration rate	Infiltration rate: Confidence limits at 0.05 level
		Minutes	Inches per hour	Inches per hour
1	Andesitic	434	1.16	0.52- 1.81
2	Andesitic	257	1.32	.66- 1.99
3	Andesitic	210	7.67	3.67-11.68
4	Andesitic	974	.61	.21- 1.01
5	Granitic	88	22.99	15.46-30.51
6	Granitic	153	16.00	10.27-21.73
Sites 1-4	Andesitic	469	2.98	1.51- 4.46
Sites 5-6	Granitic	120	19.49	14.89-24.10

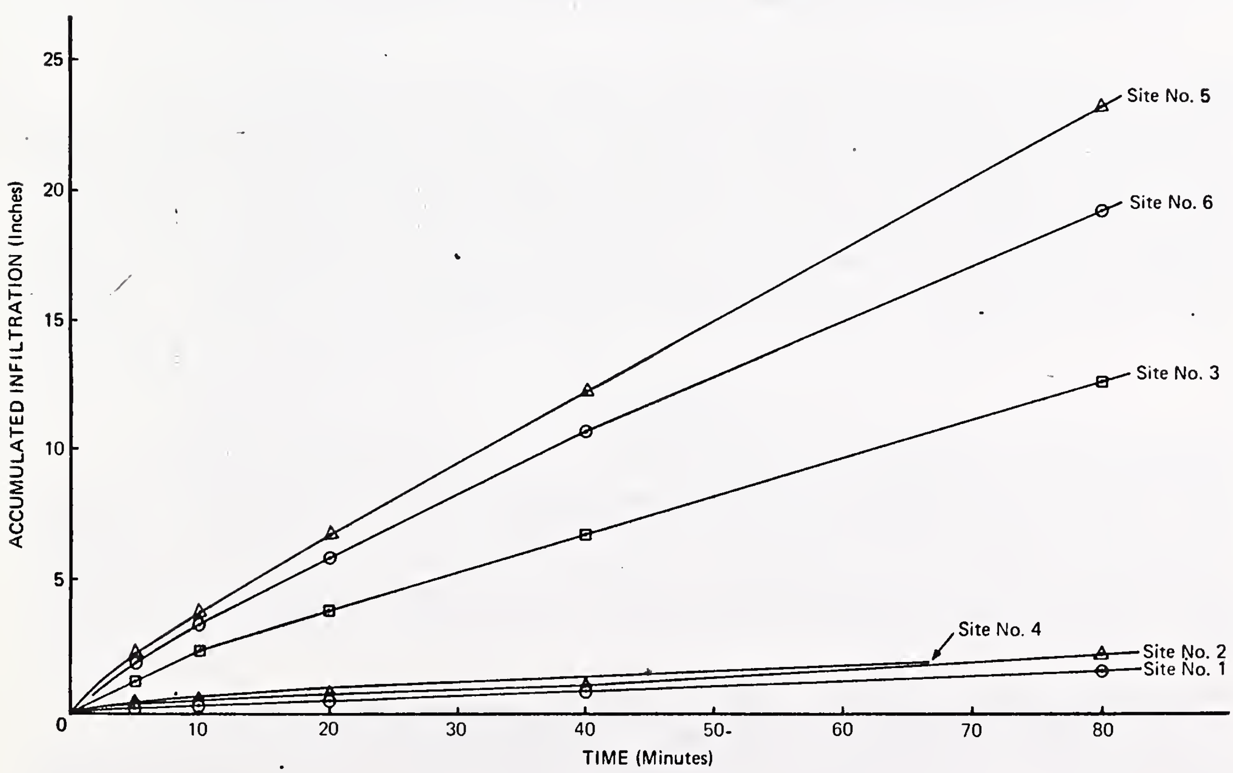

Figure 1.--Accumulated infiltration in contour trenches at six sites.

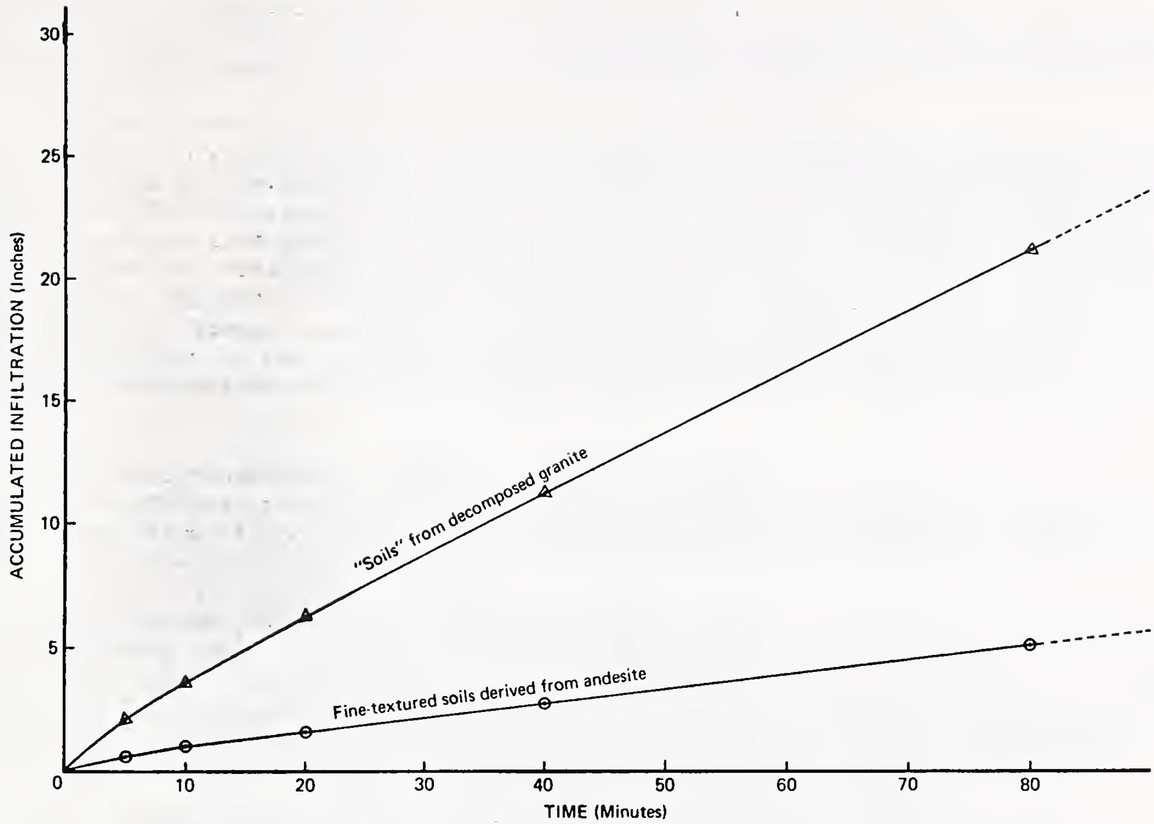

Figure 2.--Accumulated infiltration in contour trenches of decomposed granitic soils versus those of fine-textured, andesitic soils.

Sites 1, 2, and 4 have fine-textured soils derived from andesite; sites 5 and 6 have coarse-textured soils derived from decomposed granite. The soil on site 3 probably is a mixture of the two parent materials, but appeared to be of andesite origin primarily and so is included here with the andesite soils. Sites were grouped by soil parent material and the results from all tests on these sites averaged to derive the two curves of accumulated infiltration in figure 2. At the end of an hour, the graphed amount of infiltration for granitic soils was 16.3 inches and for andesitic soils 3.8 inches. These rates differ somewhat from those shown in table 1; probably because a constant (linear) rate of infiltration is assumed in table 1, whereas a curvilinear rate is shown in figure 2.

DISCUSSION

The results from 64 infiltrometer tests show a wide variation in the relative rates of infiltration in the bottoms of contour trenches constructed in the Sierra Nevada. Differences noted on individual sites show that infiltration rates can vary considerably on what appears to be a uniform soil type. Rate differences due to soil parent materials are even more striking. The hydrologic influence of contour trenches in decomposed granite would be unlike that of trenches constructed in fine-textured soils.

If all other design criteria are held constant, a contour trench system in decomposed granitic soils could successfully be designed with a smaller capacity for collecting and storing surface runoff than a system constructed in finer textured

material. In reality, of course, all criteria cannot be held constant. For example, erosion within a trench system in decomposed granite usually is so great that more storage capacity must be built into the network initially.

Contour trenching of widely different soil types conceivably would have contrastive effects on water yields. Due to the large infiltration capacity of decomposed granite, contour trenches constructed in such material should have less influence on yields from the watershed than trenches constructed on finer material. Fine-textured soils cause water to pond in the trenches for considerable time, thus permitting it to evaporate or to be consumed by vegetation on the site. The timing of water yields also may be affected. The slow percolation of water from the bottoms of trenches in fine-textured materials may serve to delay streamflow and lower runoff peaks. On the other hand, contour trenches in decomposed granite probably would not alter the timing of water yields appreciably, except for trapping overland flow and reducing flash floods in the streams.

Contour trenches trap, pond, and dispose of overland flow in much the same manner as they dispose of water in double-ring infiltrometers. Under natural conditions, water usually is rapidly ponded. Then, under the pressure of a constantly decreasing head, it slowly soaks into the soil.

When these tests were conducted, the average trench in the Dog Creek watershed had a maximum depth of 2 feet and a cross-sectional capacity of 9.3 square feet. Since the trench cross section is a gentle, open V-shape, the average head would be about a foot--even if the trench were full. Trenches are seldom full, even after intense summer storms. Consequently, an average head of 8 inches (the maximum in the ring infiltrometers) would very likely exist in partially filled trenches.

Ring infiltrometers were used when soils (even in trench bottoms) were quite dry; so initial infiltration rates were rapid. The overland flow most frequently trapped in contour trenches originates from high-intensity summer rainstorms, which usually occur when the surface soils are dry. Consequently, dry surface soils and rapid initial infiltration rates also typify natural conditions.

Despite the similarities noted between natural and study conditions, ring infiltrometer tests have their shortcomings. Ring infiltrometers usually overestimate infiltration rates.[3] Hence, they are usually used to determine relative rates of infiltration under different conditions, as was done in this study. The large diameter, double-ring infiltrometers closely approximate actual infiltration. Consequently, the author can only hope that the infiltration rates cited in this paper approximate those that would occur under natural summer conditions.

Research is now being conducted in Utah on the infiltration capacity of contour trenches.[4] These Utah tests are being made in flooded trench sections; so actual infiltration rates are being measured. This research should answer questions that may arise concerning the validity and usefulness of data from the ring-infiltrometer tests in the Sierra Nevada. In the meantime, this report will provide watershed managers with a reasonable and useful first approximation of infiltration in contour trenches.

---

[3]Herman Bouwer. A study of final infiltration rates from cylinder infiltrometers and irrigation furrows with an electrical resistance network. 7th Int. Congr. Soil Sci. Trans., Vol. I: 448-456. 1960.

[4]Paul E. Packer. Study plan INT-1603-312. Evaluation of soil and vegetation effects on the infiltration and sedimentation characteristics of contour trenches in Halfway Creek, Davis County Experimental Watershed, northern Utah. 36 p. Typescript on file, Intermountain Forest and Range Exp. Sta., Ogden, Utah. 1964.

ABOUT THE FOREST SERVICE . . .

As our Nation grows, people expect and need more from their forests—more wood; more water, fish, and wildlife; more recreation and natural beauty; more special forest products and forage. The Forest Service of the U. S. Department of Agriculture helps to fulfill these expectations and needs through three major activities:

- Conducting forest and range research at over 75 locations ranging from Puerto Rico to Alaska to Hawaii.
- Participating with all State Forestry agencies in cooperative programs to protect, improve, and wisely use our Country's 395 million acres of State, local, and private forest lands.
- Managing and protecting the 187-million acre National Forest System.

The Forest Service does this by encouraging use of the new knowledge that research scientists develop; by setting an example in managing, under sustained yield, the National Forests and Grasslands for multiple use purposes; and by cooperating with all States and with private citizens in their efforts to achieve better management, protection, and use of forest resources.

Traditionally, Forest Service people have been active members of the communities and towns in which they live and work. They strive to secure for all, continuous benefits from the Country's forest resources.

For more than 60 years, the Forest Service has been serving the Nation as a leading natural resource conservation agency.